PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-188119
(43)Date of publication of application : 04.07.2000

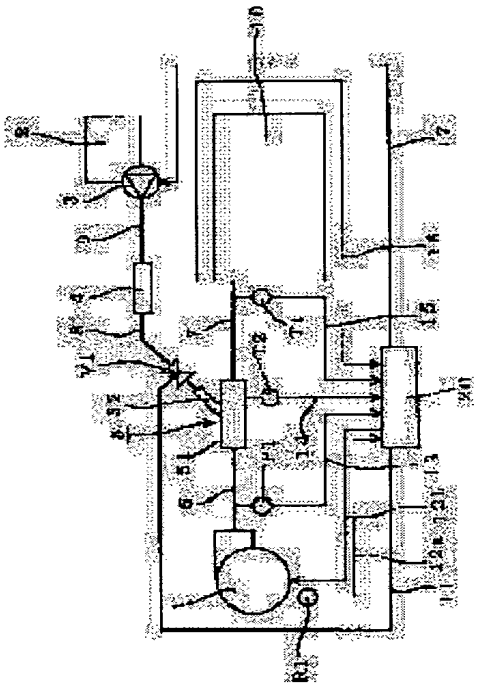
(51)Int.CI. H01M 8/04
H01M 8/10

(21)Application number : 10-363246
(22)Date of filing : 21.12.1998

(71)Applicant : AISIN SEIKI CO LTD
(72)Inventor : KURITA KENJI

(54) FUEL CELL SYSTEM AND ITS CONTROL METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a compact and inexpensive system capable of accurately controlling water flow supplied to oxidizer gas and requiring no air flow sensor.
SOLUTION: In this fuel cell system and its control method, a means of humidifying 5 to supply water to oxidizer gas is provided in an oxidizer gas pipe line 7 connecting a means of supplying oxidizer gas 1 and an oxidizer gas supply outlet of a fuel cell 10, and a means of forcibly feeding water 3 is provided in a water pipe line 9 connecting the means of humidifying 5 and a means of storing water 2, a means of detecting water flow 4 is provided in the water pipe line between the means of forcibly feeding water 3 and the means of humidifying 5, and a means of controlling 20 to control water flow by applying a feedback based on a signal from the means of detecting water flow 4.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

*.NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a fuel cell system and its control approach.
[0002]
[Description of the Prior Art] Although the cure against exhaust gas of an automobile is important and the electric vehicle is used as one of the cure of the in order to reduce atmospheric contamination as much as possible, it has not resulted in spread on problems, such as a charging equipment and mileage.
[0003] It is concluded that the automobile which a fuel cell is generated by electrochemical reaction using hydrogen and oxygen, does not have excretions other than water, is observed as a clean power plant, and used said fuel cell is most promising clean automobile. In order that a solid-state polyelectrolyte mold fuel cell may operate at low temperature also in said fuel cell, it is the most promising as an object for automobiles.
[0004] Generally the solid-state polyelectrolyte mold fuel cell system consists of the fuel cell with which the laminating of the single cel of the electrolyte which sandwiched the solid-state polyelectrolyte film with two electrodes (a fuel electrode and oxidizer pole), and a large number which pinched the zygote of an electrode with the separator is carried out, a fuel gas supply means to supply fuel gas to said fuel electrode side, an oxidizer gas supply means to supply oxidizer gas to said oxidizer pole side and various gas piping, and a control unit that controls them.
[0005] In said fuel electrode, when the hydrogen in fuel gas contacts a fuel electrode catalyst, the following reaction arises.
[0006] 2H2 -> 4H+ +4 e-H+ moves in the inside of an electrolyte, reaches an oxidizer pole catalyst, reacts with the oxygen in air, and becomes water.
[0007]
4H+ +4e- +O2 -> In order that water may also move with migration of H+ from a 2H2O fuel electrode, moisture is included in the fuel gas supplied to a fuel electrode, and it supplies. When an electrolyte is the solid-state polyelectrolyte film, also in order to maintain the electrolytic engine performance, the moisture more than a complement is included in the above-mentioned reaction, and fuel gas is supplied, and it is necessary to include moisture also in oxidizer gas and to supply.
[0008] the water supply to which the measuring valve was prepared in patent No. 2684159 as a conventional technique -- the approach of supplying the water atomized by the injection nozzle to air is indicated using the conduit. the amount of water supplied with this conventional technique -- air supply -- it is determined by the air flow rate measured by the air flow rate sensor prepared in the conduit.
[0009]
[Problem(s) to be Solved by the Invention] However, although the conventional technique is controlling the water flow rate by closing motion of a measuring valve, it has the problem which is not precise. There are many amounts of water required for the air supplied to a fuel cell as about 100 cc/min, and in order to atomize for sufficiently minute waterdrop, they need to put a

pressure on the water to supply. closing motion of a measuring valve -- water supply -- a conduit -- since an inner pressure is changed, a water flow rate stops stabilizing
[0010] Moreover, an air flow rate required for a fuel cell with large generation-of-electrical-energy outputs, such as an object for automobiles, is as large as 2000 or more NL/min, and this sensor also has the problem enlarged and formed into high cost in the system which detects an air flow rate by the sensor.
[0011] This invention is what solved the above-mentioned technical problem, can control precisely the flow rate of the water supplied to oxidizer gas, and offers the fuel cell system and its control approach of small [which does not need an air flow rate sensor], and low cost.
[0012]
[Means for Solving the Problem] In order to solve the above-mentioned technical technical problem, the technical means (the 1st technical means are called hereafter.) provided in claim 1 of this invention On the oxidizer gas pipe way which connects oxidizer gas supply opening of an oxidizer gas supply means and a fuel cell Establish a humidification means to supply water to oxidizer gas, and a water feeding means is formed in the water pipe way which connects this humidification means and a water storage means. It is the fuel cell system characterized by having formed the water flow rate detection means in the water pipe way between this water feeding means and said humidification means, and establishing the control means to which feedback is applied based on the signal from this water flow rate detection means, and which controls a water flow rate.
[0013] The effectiveness by the 1st technical means of the above is as follows.
[0014] That is, since feedback is applied based on the signal from a water flow rate detection means, it has the effectiveness which can control precisely the flow rate of the water supplied to oxidizer gas.
[0015] In order to solve the above-mentioned technical technical problem, said water feeding means is a Water pump, and the technical means (the 2nd technical means are called hereafter.) provided in claim 2 of this invention are fuel cell systems according to claim 1 characterized by controlling the rotational frequency of this Water pump based on the signal of said control means, and controlling a water flow rate.
[0016] The effectiveness by the 2nd technical means of the above is as follows.
[0017] That is, it is not necessary to establish independently a means to control a water flow rate, and a water flow rate can be controlled easily.
[0018] In order to solve the above-mentioned technical technical problem, the technical means (the 3rd technical means are called hereafter.) provided in claim 3 of this invention The return duct which branches from the water pipe way which connects said water feeding means and said water flow rate detection means, and is connected with said water tank is prepared. It is the fuel cell system according to claim 1 characterized by preparing a flow rate control means in this return duct, controlling the water flow rate which flows back to a water tank through said return duct by this flow rate control means, and controlling the water flow rate supplied to said humidification means.
[0019] The effectiveness by the 3rd technical means of the above is as follows.
[0020] That is, since it can be made to change early rather than the direction which controls a flow rate control means controls the rotational frequency of a Water pump, a water flow rate can be changed quickly.
[0021] In order to solve the above-mentioned technical technical problem, the technical means (the 4th technical means are called hereafter.) provided in claim 4 of this invention A rotational frequency detection means for an oxidizer gas supply means to be a compressor and to detect the rotational frequency of this compressor, A pressure ratio detection means to detect the pressure ratio of the inlet and delivery of this compressor is established. It is the fuel cell system according to claim 1 characterized by controlling the water flow rate which computes an oxidizer quantity of gas flow based on the signal from said rotational frequency detection means and said pressure ratio detection means, and is supplied to said humidification means based on this oxidizer quantity of gas flow.
[0022] The effectiveness by the 4th technical means of the above is as follows.

[0023] That is, since the oxidizer quantity of gas flow is computed with the rotational frequency detection means and the pressure ratio detection means, the fuel cell system of the small and the low cost which do not need the large-sized air flow rate sensor of high cost is made.
[0024] In order to solve the above-mentioned technical technical problem, the technical means (the 5th technical means are called hereafter.) provided in claim 5 of this invention A humidifier temperature detection means to detect the temperature within said humidification means, and an oxidizer gas supply opening temperature detection means to detect the temperature of oxidizer gas supply opening of said fuel cell, It is the fuel cell system according to claim 1 characterized by forming a closing motion means in the water pipe way between said humidification means and said water feeding means, and controlling said closing motion means based on the signal of said humidifier temperature detection means and said oxidizer gas supply opening temperature detection means.
[0025] The effectiveness by the 5th technical means of the above is as follows.
[0026] That is, since water can be supplied to the oxidizer gas based on the signal of a humidifier temperature detection means and an oxidizer gas supply opening temperature detection means, it can prevent supplying the water of condensation to a fuel cell.
[0027] In order to solve the above-mentioned technical technical problem, the technical means (the 6th technical means are called hereafter.) provided in claim 6 of this invention are fuel cell systems according to claim 1 characterized by equipping said humidification means with a water-injection means.
[0028] The effectiveness by the 6th technical means of the above is as follows.
[0029] That is, since a lot of water can be supplied to oxidizer gas in the state of atomization, humidification water is certainly vaporizable.
[0030] In order to solve the above-mentioned technical technical problem, the technical means (the 7th technical means are called hereafter.) provided in claim 7 of this invention In a charge cell system according to claim 5, a humidifier temperature detection means detects the temperature within a humidification means. When an oxidizer gas supply opening temperature detection means detects oxidizer gas supply opening temperature and it becomes the temperature within said humidification means, and the temperature beyond the temperature to which said oxidizer gas supply opening temperature does not liquefy a steam, it is the control approach of the fuel cell system characterized by supplying water in said humidification means.
[0031] The effectiveness by the 7th technical means of the above is as follows.
[0032] That is, since water can be supplied after becoming beyond the temperature to which the temperature within a humidification means and oxidizer gas supply opening temperature do not liquefy a steam, it can prevent supplying the water of condensation to a fuel cell.
[0033]
[Embodiment of the Invention] Hereafter, the example of this invention is explained based on a drawing.
[0034] Drawing 1 is the oxidizer gas supply section partial diagrammatic view of fuel cell systems for mount, such as an automobile of the 1st example of this invention. In the **** 1 example, air is used as oxidizer gas. This system consists of an air compressor 1, a water tank 2, Water pump 3, the water flowmeter 4, a humidifier 5, a fuel cell 10, and a control unit 20.
[0035] Said air compressor 1 is an oxidizer gas supply means to compress the air which is oxidizer gas and to supply a fuel cell 10, and is connected with said humidifier 5 through the air pipe way 6. The pressure gage P1 is formed near the outlet of said air compressor 1 of this air pipe way 6. The rotational frequency meter R1 which is a rotational frequency detection means to detect the rotational frequency is formed in said air compressor 1.
[0036] Said pressure gage P1 is a pressure ratio detection means to detect the pressure ratio of the inlet and delivery of said air compressor 1. In the **** 1 example, since the pressure of the inlet of said air compressor 1 is atmospheric pressure, the pressure measured with said pressure gage P1 serves as said pressure ratio.
[0037] Said humidifier 5 is a humidification means to supply water to oxidizer gas, and is connected with said fuel cell 10 through the air pipe way 7. The thermometer T1 which is an oxidizer gas supply opening temperature detection means to detect the temperature of oxidizer

gas supply opening into the part near the fuel cell 10 of said air pipe way 7 is formed. Said humidifier 5 consists of water ejectors 52 which are water-injection means to inject water in the humidification room 51 connected with said air pipe ways 6 and 7, and this humidifier 51. The thermometer T2 which is a detection means whenever [humidification room temperature / which detects internal temperature] is formed in said humidification room 51.
[0038] Said water ejector 52 is connected with the water flowmeter 4 which is a water flow rate detection means through the water pipe way 8. The closing motion bulb V1 which is a closing motion means is formed in this water pipe way 8. Said water flowmeter 4 is connected with Water pump 3 which is a water feeding means through the water pipe way 9. This Water pump 3 is attached to a water tank 2, is formed, pressurizes water, and supplies it to said humidifier 5.
[0039] A control unit 20 is equipment which controls closing motion of the engine speed of said air compressor 1, the engine speed of said Water pump 3, and said closing motion bulb V1. This control device 20 was connected with said closing motion bulb V1 through the signal line 11, was connected with the rotational frequency meter R1 through signal-line 12a, and is connected with the air compressor 1 through signal-line 12b.
[0040] Moreover, said control unit 20 was connected with the pressure gage P1 through the signal line 13, was connected with the thermometer T2 through the signal line 14, and is connected with the thermometer T1 through a signal line 15. Furthermore, said control unit 20 was connected with the flowmeter 4 through the signal line 16, and is connected with Water pump 3 through a signal line 17.
[0041] said signal lines 12a, 13-16 -- respectively -- a rotational frequency total -- it is the signal line which tells the signal of the measurement rotational frequency of R1, the measurement pressure of a pressure gage P1, the measurement temperature of thermometers T2 and T1, and the measurement flow rate of a flowmeter 4 to said control unit 20. Said signal lines 11, 12b, and 17 are signal lines which tell the instruction signal of said control device 20 to the closing motion bulb V1, an air compressor 1, and Water pump 3, respectively.
[0042] In the **** 1 example, an air flow rate required for a fuel cell 10 is determined from the service condition of a fuel cell system, and it is transmitted to said control unit 20. said rotational frequency total inputted from signal-line 12a in this control unit 20 -- the air flow rate which calculates from the measurement pressure of said pressure gage P1 inputted from the measurement rotational frequency and signal line 13 of R1, and is supplied, the regurgitation air flow rate, i.e., the fuel cell, of an air compressor 1, is computed.
[0043] That is, the map showing the rotational frequency of said air compressor 1 and correlation of the regurgitation air flow rate of said air compressor 1 to the measurement pressure of said pressure gage P1 is created, and it calculates based on this map. In this way, control instruction is transmitted to said air compressor 1 through signal-line 12b so that the calculated regurgitation air flow rate may turn into a need air flow rate, and the rotational frequency is controlled.
[0044] the regurgitation air flow rate of the air compressor 1 calculated above on the other hand, and the need humidification from the water/excess air ratio set up beforehand -- amount of water is decided. said control unit 20 -- a signal line 17 -- minding -- need humidification -- to send amount of water to a water ejector 52, the driver voltage of Water pump 3 is controlled and the rotational frequency of this Water pump 3 is controlled. The water flow rate actually sent is measured by the water flowmeter 4, and is transmitted to said control unit 20 through a signal line 16.
[0045] the water flow rate by which said control unit 20 was actually measured -- need humidification -- to become amount of water, feedback is applied through a signal line 17 and the rotational frequency of said Water pump 3 is controlled. the humidification supplied to a humidifier 5 by this -- amount of water becomes precise.
[0046] Humidification water is injected by the humidification room 51 with said water ejector 52, evaporates, and is supplied to a fuel cell 10 through the air pipe way 7 as a steam. When some injected humidification water continues being water, or a steam condenses, it becomes water at this time and a fuel cell 10 is supplied, there is a problem to which the air flowing path in a fuel cell 10 is plugged up, and the generation-of-electrical-energy engine performance falls.

[0047] The temperature in the humidification room 51 is measured with a thermometer T2, and the temperature of oxidizer gas supply opening of a fuel cell 10 is measured with the thermometer T1. Such temperature is transmitted to a control unit 20 through signal lines 14 and 15, respectively. When lower than the laying temperature to which one of such temperature resembled, respectively and was set beforehand, through a signal line 11, control instruction is made as the closing motion bulb V1, and, as for it, said control device 20 makes close the delivery this closing motion bulb V1. Such temperature will make open said closing motion bulb V1, if both become more than each laying temperature. Thereby, it is lost that the water of a liquid is supplied to a fuel cell 10.
[0048] Drawing 2 is the oxidizer gas supply section partial diagrammatic view of fuel cell systems for mount, such as an automobile of the 2nd example of this invention. **** 2 example only changed the flow rate control section of the humidification water of the 1st example, and other parts are the same as the 1st example. The same notation is used for the same part as the 1st example, and explanation is omitted. Air is used as oxidizer gas also in the **** 2 example.
[0049] In the **** 2 example, the return duct 21 and the control-of-flow bulb V2 are added to the 1st example. Said return duct 21 branched from the water pipe way 9, and is connected with the water tank 2. Said control-of-flow bulb V2 is the flow rate control means prepared in said said return duct 21. In the **** 2 example, the signal line 18 which transmits the control instruction of a control device 20 to said control-of-flow bulb V2 is formed.
[0050] The regurgitation air flow rate of this air compressor 1 calculates like the 1st example from the measurement rotational frequency of the rotational frequency meter R1, and the measurement pressure of a pressure gage P1. the need humidification from this regurgitation air flow rate, and the water/excess air ratio set up beforehand -- amount of water is decided. The water flow rate fed from Water pump 3 in the **** 2 example is fixed. The water flow rate sent to a water ejector 52 is performed by controlling the water flow rate which adjusts the opening of said control-of-flow bulb V2, and flows back to said water tank 2 through said return duct 21.
[0051] said control unit 20 -- a signal line 18 -- minding -- need humidification -- the opening of said control-of-flow bulb V2 is adjusted so that amount of water may be sent to a water ejector 52. The water flow rate actually sent is measured by the water flowmeter 4, and is transmitted to said control unit 20 through a signal line 16. the water flow rate by which said control unit 20 was actually measured -- need humidification -- feedback is applied through a signal line 18 and the opening of said control-of-flow bulb V2 is adjusted so that it may become amount of water. the humidification supplied to a humidifier 5 by this -- amount of water becomes precise. Since opening adjustment of the control-of-flow bulb V2 is performing control of the water flow rate by this return duct 21, a water flow rate can be quickly changed from the control made into the rotational frequency of Water pump 3.
[0052]
[Effect of the Invention] This invention on as mentioned above, the oxidizer gas pipe way which connects oxidizer gas supply opening of an oxidizer gas supply means and a fuel cell Establish a humidification means to supply water to oxidizer gas, and a water feeding means is formed in the water pipe way which connects this humidification means and a water storage means. A water flow rate detection means is formed in the water pipe way between this water feeding means and said humidification means. A humidifier temperature detection means to detect the temperature within the fuel cell system characterized by establishing the control means to which feedback is applied based on the signal from this water flow rate detection means, and which controls a water flow rate, and said humidification means, An oxidizer gas supply opening temperature detection means to detect the temperature of oxidizer gas supply opening of said fuel cell, Form a closing motion means in the water pipe way between said humidification means and said water feeding means, and a humidifier temperature detection means detects the temperature within a humidification means. When an oxidizer gas supply opening temperature detection means detects oxidizer gas supply opening temperature and it becomes the temperature within said humidification means, and the temperature beyond the temperature to which said oxidizer gas supply opening temperature does not liquefy a steam Since it is the control approach of the fuel cell system characterized by supplying water in said humidification means, the flow rate of the

water supplied to oxidizer gas can be controlled precisely, and the fuel cell system and its control approach of small [which does not need an air flow rate sensor], and low cost can be offered.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] On the oxidizer gas pipe way which connects oxidizer gas supply opening of an oxidizer gas supply means and a fuel cell Establish a humidification means to supply water to oxidizer gas, and a water feeding means is formed in the water pipe way which connects this humidification means and a water storage means. The fuel cell system characterized by having formed the water flow rate detection means in the water pipe way between this water feeding means and said humidification means, and establishing the control means to which feedback is applied based on the signal from this water flow rate detection means, and which controls a water flow rate.
[Claim 2] The fuel cell system according to claim 1 which said water feeding means is a Water pump, and is characterized by controlling the rotational frequency of this Water pump based on the signal of said control means, and controlling a water flow rate.
[Claim 3] The fuel cell system according to claim 1 characterized by to prepare the return duct which branches from the water pipe way which connects said water feeding means and said water flow rate detection means, and is connected with said water tank, to prepare a flow rate control means in this return duct, to control the water flow rate which flows back to a water tank through said return duct by this flow rate control means, and to control the water flow rate supplied to said humidification means.
[Claim 4] The fuel cell system according to claim 1 characterized by to control the water flow rate which establishes a rotational frequency detection means an oxidizer gas-supply means is a compressor and detect the rotational frequency of this compressor, and a pressure ratio detection means detect the pressure ratio of the inlet and the delivery of this compressor, computes an oxidizer quantity of gas flow based on the signal from said rotational frequency detection means and said pressure ratio detection means, and is supplied to said humidification means based on this oxidizer quantity of gas flow.
[Claim 5] The fuel cell system according to claim 1 characterized by to form a closing-motion means in the water pipe way between a humidifier temperature detection means detect the temperature within said humidification means, an oxidizer gas-supply opening temperature detection means detect the temperature of oxidizer gas-supply opening of said fuel cell, and said humidification means and said water feeding means, and to control said closing-motion means based on the signal of said humidifier temperature detection means and said oxidizer gas-supply opening temperature detection means.
[Claim 6] The fuel cell system according to claim 1 characterized by equipping said humidification means with a water-injection means.
[Claim 7] The control approach of the fuel cell system characterized by to supply water in said humidification means when a humidifier temperature detection means detects the temperature within a humidification means, an oxidizer gas-supply opening temperature detection means detects oxidizer gas-supply opening temperature in a charge cell system according to claim 5 and it becomes the temperature within said humidification means, and the temperature beyond the temperature to which said oxidizer gas-supply opening temperature does not liquefy a steam.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The oxidizer gas supply section partial diagrammatic view of fuel cell systems for mount, such as an automobile of the 1st example of this invention
[Drawing 2] The oxidizer gas supply section partial diagrammatic view of fuel cell systems for mount, such as an automobile of the 2nd example of this invention
[Description of Notations]
1 -- Air compressor (oxidizer gas supply means)
2 -- Water tank (water storage means)
3 -- Water pump (water feeding means)
4 -- Water flowmeter (water flow rate detection means)
5 -- Humidifier (humidification means)
6 Seven -- Air pipe way (oxidizer gas pipe way)
8 9 -- Water pipe way
10 -- Fuel cell
11, 12a, 12b, 13-18 -- Signal line
20 -- Control unit (control means)
21 -- Return duct
51 -- Humidification room
52 -- Water ejector (water-injection means)
P1 -- Pressure gage (pressure ratio detection means)
T1, T2 -- Thermometer (temperature detection means)
R1 -- Rotational frequency meter (rotational frequency detection means)
V1 -- Closing motion bulb (closing motion means)
V2 -- Control-of-flow bulb (flow rate control means)

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2000－188119
（P2000－188119A）
(43)公開日　平成12年７月４日(2000.7.4)

(51)Int.Cl.'	識別記号	ＦＩ		テーマコード'（参考）
Ｈ０１Ｍ　8/04		Ｈ０１Ｍ　8/04	Ｋ	５Ｈ０２６
8/10		8/10		５Ｈ０２７

審査請求　未請求　請求項の数７　ＯＬ　（全　６　頁）

(21)出願番号　特願平10－363246

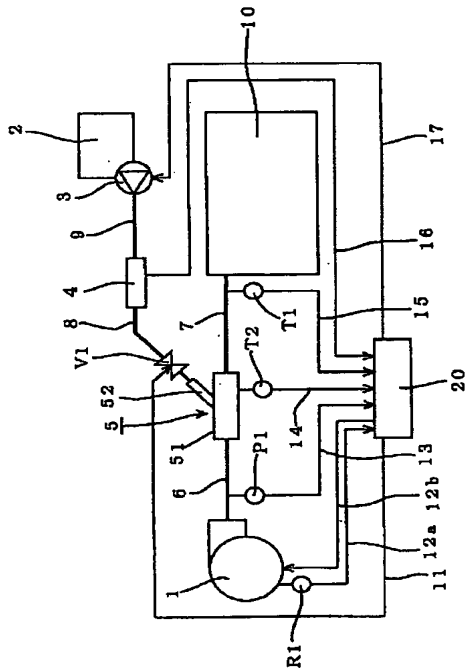
(22)出願日　平成10年12月21日(1998.12.21)

(71)出願人　000000011
アイシン精機株式会社
愛知県刈谷市朝日町２丁目１番地
(72)発明者　栗田　健志
愛知県刈谷市朝日町２丁目１番地　アイシン精機株式会社内

Ｆターム(参考)　5H026 AA06 CX04 HH00 HH08
5H027 AA06 BC11 CC04 CC06 KK22
KK48 MM04 MM16

(54)【発明の名称】　燃料電池システムおよびその制御方法

(57)【要約】
【課題】　酸化剤ガスに供給する水の流量を精確に制御でき、空気流量センサを必要としない小型、低コストのシステムにする。
【解決手段】　酸化剤ガス供給手段１と燃料電池１０の酸化剤ガス供給口を連結する酸化剤ガス管路７に、酸化剤ガスに水を供給する加湿手段５を設け、該加湿手段５と水貯蔵手段２とを連結する水管路９に水圧送手段３を設け、該水圧送手段３と前記加湿手段５の間の水管路に水流量検出手段４を設け、該水流量検出手段４からの信号に基づいてフィードバックをかけて水流量を制御する制御手段２０を設けたことを特徴とする燃料電池システムおよびその制御方法。



1

【特許請求の範囲】

【請求項１】　酸化剤ガス供給手段と燃料電池の酸化剤ガス供給口を連結する酸化剤ガス管路に、酸化剤ガスに水を供給する加湿手段を設け、該加湿手段と水貯蔵手段とを連結する水管路に水圧送手段を設け、該水圧送手段と前記加湿手段の間の水管路に水流量検出手段を設け、該水流量検出手段からの信号に基づいてフィードバックをかけて水流量を制御する制御手段を設けたことを特徴とする燃料電池システム。

【請求項２】　前記水圧送手段がウォータポンプであり、該ウォータポンプの回転数を前記制御手段の信号に基づいて制御して水流量を制御することを特徴とする請求項１記載の燃料電池システム。

【請求項３】　前記水圧送手段と前記水流量検出手段を連結する水管路から分岐して前記水タンクと連結するリターン管路を設け、該リターン管路に流量制御手段を設け、該流量制御手段により前記リターン管路を介して水タンクに還流する水流量を制御して、前記加湿手段に供給する水流量を制御することを特徴とする請求項１記載の燃料電池システム。

【請求項４】　酸化剤ガス供給手段がコンプレッサであり、該コンプレッサの回転数を検出する回転数検出手段と、該コンプレッサの吸気口と吐出口の圧力比を検出する圧力比検出手段を設け、前記回転数検出手段と前記圧力比検出手段からの信号に基づいて酸化剤ガス流量を算出し、該酸化剤ガス流量に基づいて前記加湿手段に供給する水流量を制御することを特徴とする請求項１記載の燃料電池システム。

【請求項５】　前記加湿手段内の温度を検出する加湿器温度検出手段と、前記燃料電池の酸化剤ガス供給口の温度を検出する酸化剤ガス供給口温度検出手段と、前記加湿手段と前記水圧送手段の間の水管路に開閉手段を設け、前記加湿器温度検出手段、前記酸化剤ガス供給口温度検出手段の信号に基づいて前記開閉手段を制御することを特徴とする請求項１記載の燃料電池システム。

【請求項６】　前記加湿手段が水噴射手段を備えていることを特徴とする請求項１記載の燃料電池システム。

【請求項７】　請求項５記載の料電池システムにおいて、加湿器温度検出手段で加湿手段内の温度を検出し、酸化剤ガス供給口温度検出手段で酸化剤ガス供給口温度を検出し、前記加湿手段内の温度と前記酸化剤ガス供給口温度が水蒸気を液化しない温度以上の温度になった時に、前記加湿手段内に水を供給することを特徴とする燃料電池システムの制御方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は燃料電池システムおよびその制御方法に関する。

【０００２】

【従来の技術】大気の汚染をできる限り減らすために自

2

動車の排ガス対策が重要になっており、その対策の一つとして電気自動車が使用されているが、充電設備や走行距離などの問題で普及に至っていない。

【０００３】燃料電池は、水素と酸素を使用して電気化学反応で発電し、水以外の排出物がなくクリーンな発電装置として注目されており、前記燃料電池を使用した自動車が最も将来性のあるクリーンな自動車であると見られている。前記燃料電池の中でも固体高分子電解質型燃料電池が低温で作動するため自動車用として最も有望である。

【０００４】固体高分子電解質型燃料電池システムは、一般的に二つの電極（燃料極と酸化剤極）で固体高分子電解質膜を挟んだ電解質と電極の接合体をセパレータで挟持した多数の単セルが積層されている燃料電池、前記燃料極側に燃料ガスを供給する燃料ガス供給手段、前記酸化剤極側に酸化剤ガスを供給する酸化剤ガス供給手段および各種ガス配管と、それらを制御する制御装置から構成されている。

【０００５】前記燃料極では燃料ガス中の水素が燃料極触媒に接触することにより下記の反応が生ずる。

【０００６】$2H_2 \rightarrow 4H^+ + 4e^-$

H^+ は、電解質中を移動し酸化剤極触媒に達し空気中の酸素と反応して水となる。

【０００７】

$4H^+ + 4e^- + O_2 \rightarrow 2H_2O$

燃料極からのH^+ の移動に伴い水も移動するため燃料極に供給する燃料ガスに水分を含ませて供給している。電解質が固体高分子電解質膜の場合は、電解質の性能を維持するためにも、燃料ガスには上記の反応に必要な量以上の水分を含ませて供給し、酸化剤ガスにも水分を含ませて供給する必要がある。

【０００８】従来技術として、特許第２６８４１５９号には、計量弁が設けられた水供給導管を用いて、噴射ノズルで霧化された水を空気に供給する方法が開示されている。この従来技術では、供給する水量は空気供給導管に設けられた空気流量センサにより測定される空気流量により決められている。

【０００９】

【発明が解決しようとする課題】しかしながら、従来技術は、計量弁の開閉により水流量を制御しているが、実際の流量を検出する手段が設けられていないので供給する水流量が精確でない問題がある。燃料電池に供給する空気に必要な水の量は約１００ｃｃ／ｍｉｎと多く、十分微小な水滴に霧化するためには供給する水に圧力をかける必要がある。計量弁の開閉により水供給導管内の圧力が変動するので、水流量が安定しなくなる。

【００１０】また、自動車用等発電出力の大きい燃料電池に必要な空気流量は２０００ＮＬ／ｍｉｎ以上と大きく、空気流量をセンサで検出するシステムでは該センサが大型化し高コスト化する問題もある。

【００１１】本発明は上記課題を解決したもので、酸化剤ガスに供給する水の流量を精確に制御でき、空気流量センサを必要としない小型、低コストの燃料電池システムおよびその制御方法を提供する。

【００１２】

【課題を解決するための手段】上記技術的課題を解決するために、本発明の請求項１において講じた技術的手段（以下、第１の技術的手段と称する。）は、酸化剤ガス供給手段と燃料電池の酸化剤ガス供給口を連結する酸化剤ガス管路に、酸化剤ガスに水を供給する加湿手段を設け、該加湿手段と水貯蔵手段とを連結する水管路に水圧送手段を設け、該水圧送手段と前記加湿手段の間の水管路に水流量検出手段を設け、該水流量検出手段からの信号に基づいてフィードバックをかけて水流量を制御する制御手段を設けたことを特徴とする燃料電池システムである。

【００１３】上記第１の技術的手段による効果は、以下のようである。

【００１４】すなわち、水流量検出手段からの信号に基づいてフィードバックをかけているので、酸化剤ガスに供給する水の流量を精確に制御できる効果を有する。

【００１５】上記技術的課題を解決するために、本発明の請求項２において講じた技術的手段（以下、第２の技術的手段と称する。）は、前記水圧送手段がウォータポンプであり、該ウォータポンプの回転数を前記制御手段の信号に基づいて制御して水流量を制御することを特徴とする請求項１記載の燃料電池システムである。

【００１６】上記第２の技術的手段による効果は、以下のようである。

【００１７】すなわち、水流量を制御する手段を別に設ける必要がなく、簡単に水流量を制御することができる。

【００１８】上記技術的課題を解決するために、本発明の請求項３において講じた技術的手段（以下、第３の技術的手段と称する。）は、前記水圧送手段と前記水流量検出手段を連結する水管路から分岐して前記水タンクと連結するリターン管路を設け、該リターン管路に流量制御手段を設け、該流量制御手段により前記リターン管路を介して水タンクに還流する水流量を制御して、前記加湿手段に供給する水流量を制御することを特徴とする請求項１記載の燃料電池システムである。

【００１９】上記第３の技術的手段による効果は、以下のようである。

【００２０】すなわち、流量制御手段を制御する方がウォータポンプの回転数を制御するより早く変化させることができるので、水流量を敏速に変化させることができる。

【００２１】上記技術的課題を解決するために、本発明の請求項４において講じた技術的手段（以下、第４の技術的手段と称する。）は、酸化剤ガス供給手段がコンプレッサであり、該コンプレッサの回転数を検出する回転数検出手段と、該コンプレッサの吸気口と吐出口の圧力比を検出する圧力比検出手段を設け、前記回転数検出手段と前記圧力比検出手段からの信号に基づいて酸化剤ガス流量を算出し、該酸化剤ガス流量に基づいて前記加湿手段に供給する水流量を制御することを特徴とする請求項１記載の燃料電池システムである。

【００２２】上記第４の技術的手段による効果は、以下のようである。

【００２３】すなわち、回転数検出手段と圧力比検出手段で酸化剤ガス流量を算出しているので、大型で高コストの空気流量センサを必要としない小型かつ低コストの燃料電池システムができる。

【００２４】上記技術的課題を解決するために、本発明の請求項５において講じた技術的手段（以下、第５の技術的手段と称する。）は、前記加湿手段内の温度を検出する加湿器温度検出手段と、前記燃料電池の酸化剤ガス供給口の温度を検出する酸化剤ガス供給口温度検出手段と、前記加湿手段と前記水圧送手段の間の水管路に開閉手段を設け、前記加湿器温度検出手段、前記酸化剤ガス供給口温度検出手段の信号に基づいて前記開閉手段を制御することを特徴とする請求項１記載の燃料電池システムである。

【００２５】上記第５の技術的手段による効果は、以下のようである。

【００２６】すなわち、加湿器温度検出手段、酸化剤ガス供給口温度検出手段の信号に基づいての酸化剤ガスに水を供給できるので、凝縮水が燃料電池に供給されることを防ぐことができる。

【００２７】上記技術的課題を解決するために、本発明の請求項６において講じた技術的手段（以下、第６の技術的手段と称する。）は、前記加湿手段が水噴射手段を備えていることを特徴とする請求項１記載の燃料電池システムである。

【００２８】上記第６の技術的手段による効果は、以下のようである。

【００２９】すなわち、大量の水を霧化状態で酸化剤ガスに供給することができるので、加湿水を確実に気化できる。

【００３０】上記技術的課題を解決するために、本発明の請求項７において講じた技術的手段（以下、第７の技術的手段と称する。）は、請求項５記載の料電池システムにおいて、加湿器温度検出手段で加湿手段内の温度を検出し、酸化剤ガス供給口温度検出手段で酸化剤ガス供給口温度を検出し、前記加湿手段内の温度と前記酸化剤ガス供給口温度が水蒸気を液化しない温度以上の温度になった時に、前記加湿手段内に水を供給することを特徴とする燃料電池システムの制御方法である。

【００３１】上記第７の技術的手段による効果は、以下のようである。

【００３２】すなわち、加湿手段内の温度と酸化剤ガス供給口温度が水蒸気を液化しない温度以上になってから水を供給することができるので、凝縮水が燃料電池に供給されることを防ぐことができる。

【００３３】

【発明の実施の形態】以下、本発明の実施例について、図面に基づいて説明する。

【００３４】図１は本発明の第１実施例の自動車等車載用燃料電池システムの酸化剤ガス供給部部分図である。本第１実施例では、酸化剤ガスとして空気を使用している。本システムは、エアコンプレッサ１、水タンク２、ウォータポンプ３、水流量計４、加湿器５、燃料電池１０および制御装置２０から構成されている。

【００３５】前記エアコンプレッサ１は、酸化剤ガスである空気を圧縮して燃料電池１０に供給する酸化剤ガス供給手段で、空気管路６を介して前記加湿器５と連結している。該空気管路６の前記エアコンプレッサ１の出口付近に圧力計Ｐ１が設けられている。前記エアコンプレッサ１にはその回転数を検出する回転数検出手段である回転数計Ｒ１が設けられている。

【００３６】前記圧力計Ｐ１は前記エアコンプレッサ１の吸気口と吐出口の圧力比を検出する圧力比検出手段である。本第１実施例では、前記エアコンプレッサ１の吸気口の圧力は大気圧であるので、前記圧力計Ｐ１で計測された圧力が前記圧力比となっている。

【００３７】前記加湿器５は酸化剤ガスに水を供給する加湿手段で、空気管路７を介して前記燃料電池１０と連結している。前記空気管路７の燃料電池１０に近い部分に酸化剤ガス供給口の温度を検出する酸化剤ガス供給口温度検出手段である温度計Ｔ１が設けられている。前記加湿器５は前記空気管路６および７と連結している加湿室５１と該加湿器５１内に水を噴射する水噴射手段である水噴射ポンプ５２から構成されている。前記加湿室５１には内部の温度を検出する加湿室温度検出手段である温度計Ｔ２が設けられている。

【００３８】前記水噴射ポンプ５２は水管路８を介して水流量検出手段である水流量計４と連結している。該水管路８には開閉手段である開閉バルブＶ１が設けられている。前記水流量計４は水管路９を介して水圧送手段であるウォータポンプ３と連結している。該ウォータポンプ３は水タンク２に付属して設けられ、水を加圧して前記加湿器５に供給するものである。

【００３９】制御装置２０は、前記エアコンプレッサ１の回転数、前記ウォータポンプ３の回転数および前記開閉バルブＶ１の開閉を制御する装置である。該制御装置２０は信号線１１を介して前記開閉バルブＶ１と連結し、信号線１２ａを介して回転数計Ｒ１と連結し、信号線１２ｂを介してエアコンプレッサ１と連結している。

【００４０】また、前記制御装置２０は信号線１３を介して圧力計Ｐ１と連結し、信号線１４を介して温度計Ｔ２と連結し、信号線１５を介して温度計Ｔ１と連結している。さらに前記制御装置２０は信号線１６を介して流量計４と連結し、信号線１７を介してウォータポンプ３と連結している。

【００４１】前記信号線１２ａ、１３～１６はそれぞれ回転数計Ｒ１の計測回転数、圧力計Ｐ１の計測圧力、温度計Ｔ２、Ｔ１の計測温度、流量計４の計測流量の信号を前記制御装置２０に伝える信号線である。前記信号線１１、１２ｂ、１７は前記制御装置２０の命令信号をそれぞれ開閉バルブＶ１、エアコンプレッサ１、ウォータポンプ３に伝える信号線である。

【００４２】本第１実施例では、燃料電池システムの運転条件から燃料電池１０に必要な空気流量を決定し前記制御装置２０に伝達される。該制御装置２０では信号線１２ａから入力された前記回転数計Ｒ１の計測回転数と信号線１３から入力された前記圧力計Ｐ１の計測圧力から演算しエアコンプレッサ１の吐出空気流量すなわち燃料電池に供給されている空気流量を算出する。

【００４３】すなわち、前記エアコンプレッサ１の回転数と前記圧力計Ｐ１の計測圧力に対する前記エアコンプレッサ１の吐出空気流量の相関をあらわすマップを作成して、該マップに基づいて演算する。こうして求めた吐出空気流量が必要空気流量になるように信号線１２ｂを介して前記エアコンプレッサ１に制御命令を伝達し、その回転数を制御する。

【００４４】一方、上記で演算されたエアコンプレッサ１の吐出空気流量とあらかじめ設定された水／空気比から必要加湿水量が決まる。前記制御装置２０は信号線１７を介して必要加湿水量を水噴射ポンプ５２に送るようにウォータポンプ３の駆動電圧を制御し該ウォータポンプ３の回転数を制御する。実際に送られている水流量は水流量計４により計測され信号線１６を介して前記制御装置２０に伝達される。

【００４５】前記制御装置２０は、実際に計測された水流量が必要加湿水量になるように信号線１７を介してフィードバックをかけ前記ウォータポンプ３の回転数を制御する。これにより加湿器５に供給される加湿水量は精確になる。

【００４６】加湿水は前記水噴射ポンプ５２により加湿室５１に噴射され蒸発して水蒸気として空気管路７を介して燃料電池１０に供給される。この時、噴射された加湿水の一部が水のままであったり、水蒸気が凝縮して水になったりして燃料電池１０に供給されると、燃料電池１０内の空気通流路がふさがれ発電性能が低下する問題がある。

【００４７】温度計Ｔ２により加湿室５１内の温度、温度計Ｔ１により燃料電池１０の酸化剤ガス供給口の温度が計測されている。これらの温度はそれぞれ信号線１４、１５を介して制御装置２０に伝達される。もし、これらの温度のどちらかがそれぞれにあらかじめ設定され

た設定温度より低い場合、前記制御装置２０は信号線１１を介して制御命令を開閉バルブＶ１に送り該開閉バルブＶ１を閉にする。これらの温度が両方ともそれぞれの設定温度以上になったら前記開閉バルブＶ１を開にする。これにより、燃料電池１０に液体の水が供給されることがなくなる。

【００４８】図２は本発明の第２実施例の自動車等車載用燃料電池システムの酸化剤ガス供給部部分図である。本第２実施例は第１実施例の加湿水の流量制御部を変えただけで、他の部分は第１実施例と同じである。第１実施例と同じ部分には同じ記号を使用し、説明は省略する。本第２実施例でも酸化剤ガスとして空気を使用している。

【００４９】本第２実施例では、第１実施例にリターン管路２１および流量制御バルブＶ２が追加されている。前記リターン管路２１は水管路９から分岐して水タンク２と連結している。前記流量制御バルブＶ２は前記前記リターン管路２１に設けられた流量制御手段である。本第２実施例では、制御装置２０の制御命令を前記流量制御バルブＶ２に伝達する信号線１８が設けられている。

【００５０】第１実施例と同様に回転数計Ｒ１の計測回転数と圧力計Ｐ１の計測圧力から該エアコンプレッサ１の吐出空気流量が演算される。該吐出空気流量とあらかじめ設定された水／空気比から必要加湿水量が決まる。本第２実施例では、ウォータポンプ３から圧送される水流量は一定である。水噴射ポンプ５２に送る水流量は、前記流量制御バルブＶ２の開度を調整して前記リターン管路２１を介して前記水タンク２に還流する水流量を制御することによって行う。

【００５１】前記制御装置２０は信号線１８を介して必要加湿水量を水噴射ポンプ５２に送るように前記流量制御バルブＶ２の開度を調整する。実際に送られている水流量は水流量計４により計測され信号線１６を介して前記制御装置２０に伝達される。前記制御装置２０は、実際に計測された水流量が必要加湿水量になるように信号線１８を介してフィードバックをかけ前記流量制御バルブＶ２の開度を調整する。これにより加湿器５に供給される加湿水量は精確になる。このリターン管路２１による水流量の制御は、流量制御バルブＶ２の開度調整により行っているので、ウォータポンプ３の回転数にする制御より水流量を敏速に変化させることができる。

【００５２】

【発明の効果】以上のように、本発明は、酸化剤ガス供給手段と燃料電池の酸化剤ガス供給口を連結する酸化剤ガス管路に、酸化剤ガスに水を供給する加湿手段を設け、該加湿手段と水貯蔵手段とを連結する水管路に水圧送手段を設け、該水圧送手段と前記加湿手段の間の水管路に水流量検出手段を設け、該水流量検出手段からの信号に基づいてフィードバックをかけて水流量を制御する制御手段を設けたことを特徴とする燃料電池システムおよび前記加湿手段内の温度を検出する加湿器温度検出手段と、前記燃料電池の酸化剤ガス供給口の温度を検出する酸化剤ガス供給口温度検出手段と、前記加湿手段と前記水圧送手段の間の水管路に開閉手段を設け、加湿器温度検出手段で加湿手段内の温度を検出し、酸化剤ガス供給口温度検出手段で酸化剤ガス供給口温度を検出し、前記加湿手段内の温度と前記酸化剤ガス供給口温度が水蒸気を液化しない温度以上の温度になった時に、前記加湿手段内に水を供給することを特徴とする燃料電池システムの制御方法であるので、酸化剤ガスに供給する水の流量を精確に制御でき、空気流量センサを必要としない小型、低コストの燃料電池システムおよびその制御方法が提供できる。

【図面の簡単な説明】

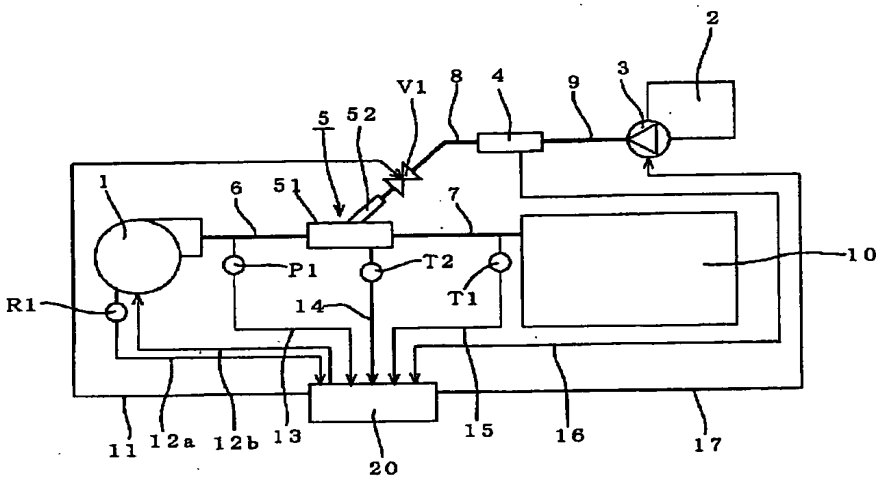
【図１】本発明の第１実施例の自動車等車載用燃料電池システムの酸化剤ガス供給部部分図

【図２】本発明の第２実施例の自動車等車載用燃料電池システムの酸化剤ガス供給部部分図

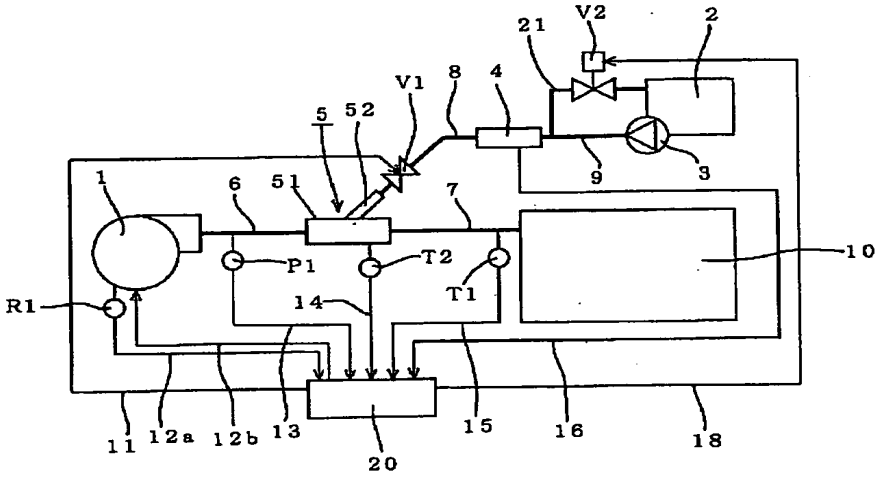
【符号の説明】

１…エアコンプレッサ（酸化剤ガス供給手段）
２…水タンク（水貯蔵手段）
３…ウォータポンプ（水圧送手段）
４…水流量計（水流量検出手段）
５…加湿器（加湿手段）
６、７…空気管路（酸化剤ガス管路）
８、９…水管路
１０…燃料電池
１１、１２ａ、１２ｂ、１３～１８…信号線
２０…制御装置（制御手段）
２１…リターン管路
５１…加湿室
５２…水噴射ポンプ（水噴射手段）
Ｐ１…圧力計（圧力比検出手段）
Ｔ１、Ｔ２…温度計（温度検出手段）
Ｒ１…回転数計（回転数検出手段）
Ｖ１…開閉バルブ（開閉手段）
Ｖ２…流量制御バルブ（流量制御手段）

【図１】


2
3
4
8
9
V1
5
52
1
6
51
7
10
P1
T2
T1
R1
14
11
12a
12b
13
20
15
16
17

【図２】


21
V2
2
V1
8
4
5
52
9
3
1
6
51
7
10
P1
T2
T1
R1
14
11
12a
12b
13
20
15
16
18